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OCULOMETRIC SURVEILLANCE OF NEURO-OCULAR FUNCTION

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Introduction

- NASA Ames has developed an eye-movement-based, or “oculometric” methodology that generates 19 largely **independent functional metrics** of human visual/visuomotor performance (*IWS2022 abstract #1133-000402*).
- Multidimensional oculometrics allow for the **examination of the underlying neural subsystems** of voluntary visuomotor and ocular control (i.e., pursuit, saccades, visual motion processing, eccentric gaze holding, pupillary light reflex) and thus the neural processing along multiple brain pathways.
- Oculometric methods could therefore provide NASA with a sensitive, reliable, rapid ready-to-perform assessment tools to **detect and monitor the level of SANS and other spaceflight-related mild performance impairments**.
- Here we examine the effects of chronic hydroxychloroquine – a stressor that induces retinal thinning – on **oculometric performance and its correlation with differences in retinal thickness**, a signature component of SANS.



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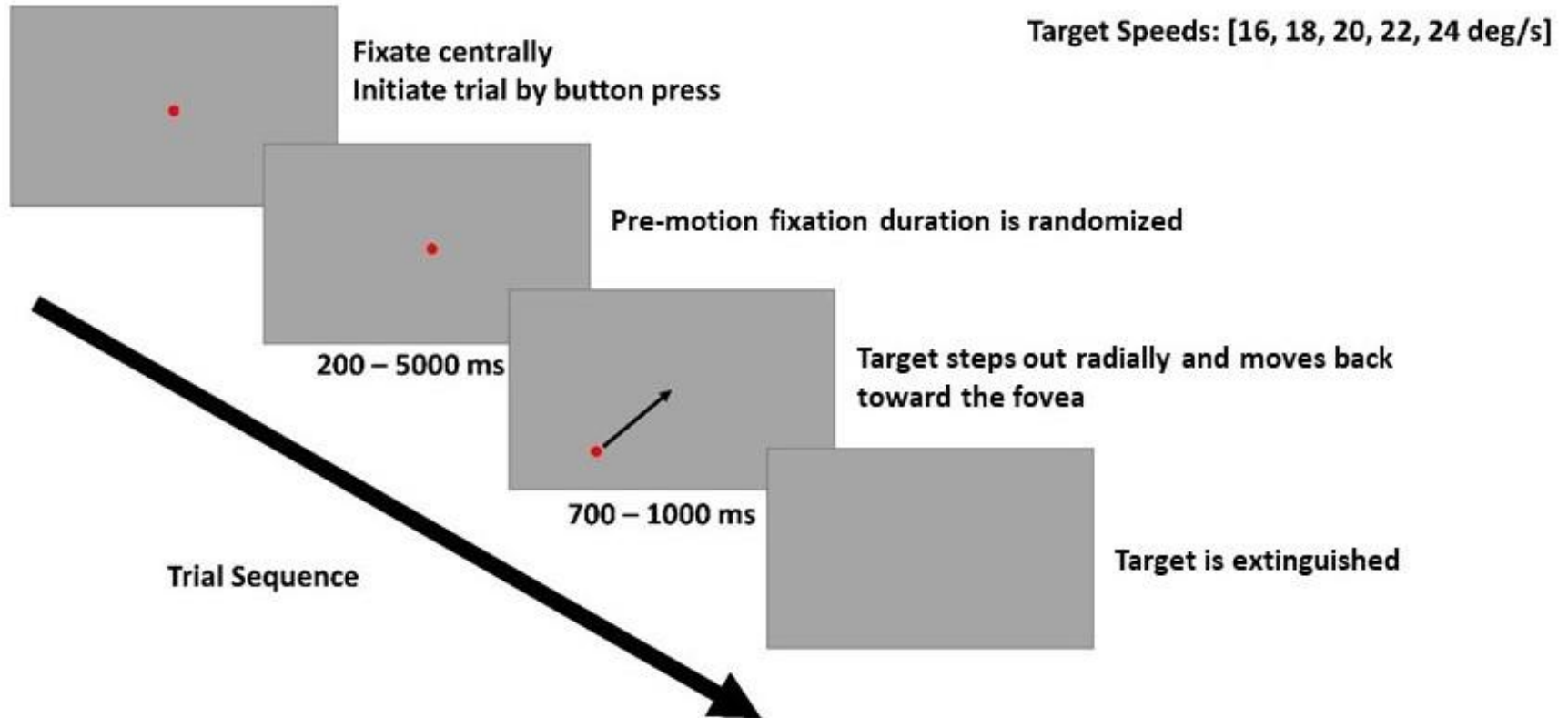
Overall Plan

- Recruit patients (18-75 yro) experiencing or at risk for any of several different degenerative retinal pathologies along with age-matched, healthy controls.
- Collect clinically prescribed imaging and diagnostic data (including OCT) based exclusively on their clinician's best medical judgment, unaltered by their participation in this study.
- Perform two sequential sessions of an eye-tracking task under monocular viewing conditions, collecting data from each eye separately.
- Correlate our independent oculometric measures with quantitative clinical measures to determine if oculometrics of various visuomotor subsystem functions could be predictive of clinical outcome.

We report here preliminary findings for oculometric measures of early visual function by showing the Pearson correlation with perifoveal retinal thickness.

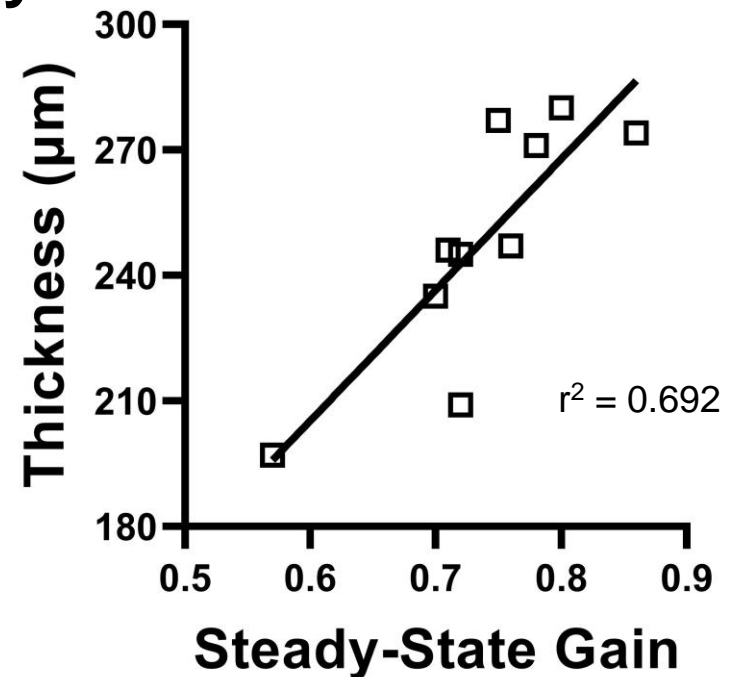
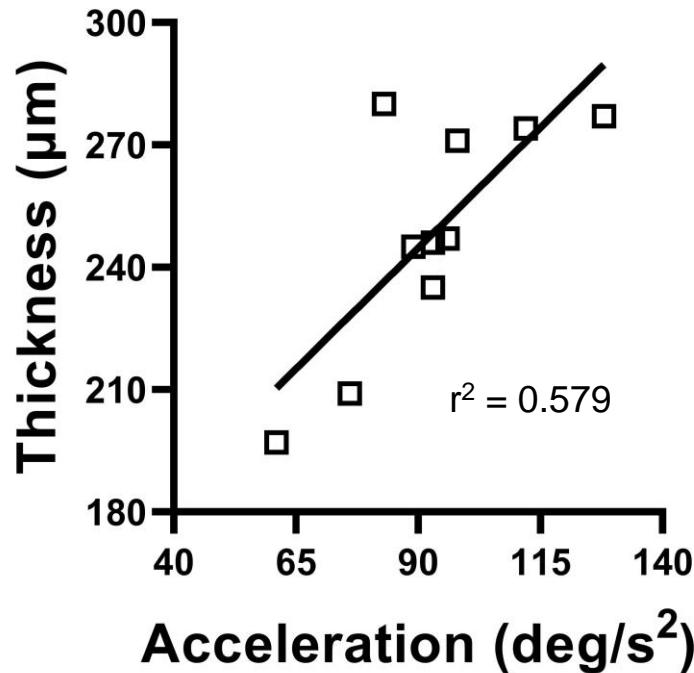


Oculometric Task



- Five-minute ocular tracking task (after a one-minute calibration process), with 90 two-second trials capturing the coordinated pursuit and saccadic responses to a range of target speeds and directions, allow us to compute 9 core oculometrics of early vision.

Preliminary Data



- 5 Subjects (all ♀, 34-60 yro) on a long-term course of hydroxychloroquine treatment (2-7mg/kg/day for 10-23 yrs) underwent oculometric and OCT testing.
- We compared candidate oculometrics and average retinal thickness across the 10 retinae, testing 9 independent hypotheses of potential components of functional impairment:
 - Initial pursuit acceleration (open-loop gain) and steady-state pursuit gain showed highly significant correlations (1-tailed $P = 0.005$ and 0.001 , respectively), independent of age ($r^2 = 0.034$, $P > 0.3$).
 - Pursuit latency showed weak ($r^2 = 0.364$, $P = 0.032$) and speed responsivity borderline ($r^2 = 0.253$, $P = 0.069$) correlation across our small sample, and
 - Remaining oculometrics tested appear unrelated to thickness or less so ($r^2 \leq 0.1$).



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Conclusions

- Two of our oculometrics are strong indicators of pathological retinal thinning.
- Oculometrics link subtle anatomical pathology (retinal thickness decrement) with differences in performance (increased latency, decreased open/closed loop pursuit gain) in an at-risk, yet clinically asymptomatic population.
- Oculometrics provide a sensitive and objective assessment of retinal and posterior segment health status that can detect pathological changes in retinal thickness in a sample of only 5 subjects without baseline measures, although we also intend to perform a comparison with age-matched controls.
- Oculometrics has the potential to allow NASA to efficiently:
 - Detect visual and visuomotor deficits associated with SANS and other spaceflight pathology even before clinical evidence of structural changes,
 - Gain insight into the nature of operational risks of such mild impairment,
 - Assess the extent and time-course of progression or functional recovery in longitudinal studies, and the effectiveness of countermeasures.